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young ones should be made in order to be sure that the young were really in the alimentary canal and not in the oviducts. It is also of importance to ascertain if young snakes, after having been swallowed by the parent, ever enter the stomach or are confined to the space in the œsophagus above it. This can be discovered by cutting open the throat and following down to the stomach, which in most species is situated from about one third to one half the distance between the mouth and the termination of the alimentary canal, and can readily be determined by its thicker walls and more numerous folds on its inside, which are very marked when the stomach is not distended with food.

THE LAKES OF IOWA,—PAST AND PRESENT.

BY C. A. WHITE, M. D.

LAKES of Iowa ! reiterates some New England reader, and, seeing no large bodies of water represented on the map of that Commonwealth, he really thinks ponds must be meant. Well, be it so, but the writer hereof is a western man, and in the West all collections of fresh water, whether large or small, are called lakes or lakelets. Perhaps, however, he has heard the stories of the "walled lakes" of Iowa, in which the wondrous handiwork of a departed race of men is described, consisting of walls of huge stones encircling the lakes like that of an artificial fish-pond, so raised as to prevent an overflow of water upon the adjacent low ground; sloping down to the water's edge with a pavement like a Mississippi levee; rounded and graded with earth upon the top, forming a good road upon which the Jehus of that departed race doubtless drove their elk or buffalo chariots in pursuit of pleasure or of their daily avocations; and the whole finished with a garniture of sage reflections upon the mutability of human affairs. Such fantastic stories have been frequent in our newspapers for several years, rendering those modest little lakelets so famous that many pilgrimages have been made to their borders with the hope of finding something to aid in penetrating the mystery that shrouds the early human history of our continent.

It is such lakelets as these and their origin that will now in part engage our attention; and while showing the groundlessness of the stories referred to, we hope to present still more interesting and wonderful facts, because in the realm of Nature truth *is* stranger than fiction.

First, let us go back to their origin, for they originated from causes so definite that we are often able to comprehend them as clearly as if we saw them in operation; and the time of their formation in relation to other geological changes is as accurately determined as that of any other. Not only have the lakes had a definite origin, but, as we shall presently see, some of them have also had an end, and we know they once existed only by means of the records they have left in the earth they once covered. Hence the addendum to the above title,—past and present.

Lakes have doubtless existed upon the earth's surface in every geological age; but those of which we are speaking had their origin at a period really very remote when considered in relation to the historic era, but *very* recent when compared with the geological ages which preceded it.

At the close of the Glacial epoch the ice disappeared from the temperate zone, the present condition of the climate was established, and the continent assumed very nearly its present dimensions and form. The northern part of the Great Valley—it is to this region to which more especial reference is made—was not then marked by strong topographical features, for it was traversed by no ranges of mountains, nor by any rivers or streams. Shallow depressions only, which were filled with water from the rains and the melting ice, marked the surface. These were the primitive lakelets, and existed before any definite streams were formed. Where the depressions were longitudinal, or connected in chains, they gave initial direction to the courses of the streams into which the surface-waters were gathered and carried away to the sea. These are the streams of to-day, and their ceaseless flow, aided by the rains and frosts of the unnumbered years that have passed since then, have worn their own channels down, not only through the incoherent drift, but often also through solid stratified rocks, the edges of which we see protruding from their valley slopes. Thus all the valleys of this region are valleys of erosion, and it is meteorological erosion alone that has given it its most prominent physical features.

As one stands upon the broad level prairies of Southern Iowa, and sweeps the well-defined ocean-like horizon with his level, he finds the bubble everywhere resting upon the cross-wire except where the distant dark line of forest foliage reveals the presence of a stream. Approaching this, the surface becomes undulating like the smooth rolling of a sea; but looking closely he will see that every depression leads into a still deeper one until the upper branches of the streams are reached, the surfaces of which are often more than one hundred and fifty feet below the prairie level from which he started; and the surfaces of the larger streams are sometimes a hundred feet deeper still. The higher prairie-surface of to-day is the same surface which was left by the retiring waters at the close of the Glacial epoch, and the time which has passed since then—that during which the valleys were formed—is called by geologists the Terrace epoch, because the oscillations of the streams from side to side of their valleys in the process of their erosion have left frequent terraces of material which successively constituted "flats" or "bottoms" bordering the streams, but which are now far above the reach of their highest floods. The Terrace epoch verges upon the present time, because the same streams still flow, and earthy matter is still carried by them to the sea, as rapidly perhaps as it ever was, although only occasionally sufficient in amount to muddy the water. Thus it will be seen how slowly the mightiest operations of Nature are performed; for this most recent of the geological changes has doubtless required a length of time so great that the human mind is incapable of comprehending it.

In Northern Iowa the prairie horizons are not so clearly defined as they are farther to the southward, and it was doubtless so at the beginning. The drift also contains more gravel and bowlders there, from the fact that nearly all of those materials originating still farther to the northward, their abundance diminished with the diminishing force of the glaciers to the southward. Numerous irregular rounded elevations or knobs mark the surface, between which are corresponding depressions; not produced however by erosion since the drift was deposited, as the river valleys were, but are, like the knobs, inequalities left by the glaciers.

Some of these depressions have become drained; some of them are still occupied by the lakelets, and some by peat marshes. Streams are numerous in Southern Iowa, and their valleys deep. Consequently the country is so well drained that all trace of the primitive lakelets is usually obliterated. But many of those streams have their rise in Northern Iowa, and many of those lakelets still exist there, because no accumulation of water beyond has sent a current across them to cut a channel for their outlet. Lake basins are sometimes hollowed very deeply into the earth, showing bold exposures of stratified or unstratified rocks upon their shores. But the lakelets of which we are speaking, had their origin in shallow depressions left in the surface of the drift alone at the close of the Glacial epoch. By the action of subsequent causes they, in certain regions, became "walled lakes;" for a majority of them are as worthy of that designation as those are of which the fanciful stories have been told. Nor are lakes of that character confined to Iowa alone, but are known also in Minnesota, Wisconsin, Michigan, and even in Connecticut; yet all except two, one in Wright county, and the other in Sac county, Iowa, seem never to have been favored with the visits of an imaginative writer to tell fanciful stories of their associated remains of human handiwork.

It seemed necessary to make the foregoing statement of facts, and the geological principles which they involve, before attempting a description of the lakelets themselves, that such a description might thus be rendered more intelligible, and which is here given as the result of long-continued observation of sixteen such lakelets in Northern Iowa, including the two which have become noted as walled lakes.

They usually occupy an open prairie region. Sometimes small groves are near them, but trees are often entirely wanting, especially since the settlers mercilessly destroy them for fuel. They are from one to five miles across, but always very shallow, because the undulations within which they rest are very gentle. None of them are more than fifteen feet deep, and the majority are so shallow that they permit a luxuriant growth of wild rice and other aquatic plants from their bottoms over the whole, or a large part of their areas, among which water-fowl find shelter and abundant food, but which renders them rather uninteresting features of the landscape.

A true description of the so-called walls, but which we shall term embankments, will be best understood if given in connection with a description of their origin. When a pile of sand, obtained from the river shore, has been left by the workmen for a long time exposed to the washings of the rains, the gravel which it contains, and which at first is hardly visible, becomes in some cases even more conspicuous than the sand itself, because a part of the latter has been wasted, while the gravel remains. Thus it has been upon an extended scale with the drift, which, as before stated, is composed of bowlders, gravel, sand, clay, and soil, although little except the latter is usually seen upon the prairie surfaces. Sometimes the drift is more than a hundred feet thick, and all the bowlders contained in the whole mass which has been swept out to form the valleys have gradually rolled down upon their slopes, and many of them into the streams. For this reason we usually find them more numerous upon surfaces that have suffered erosion than anywhere else. Again; the ceaseless dashing of a lakelet's waves stir up the finer material beneath its waters, to be carried away in the form of muddy water at the times of its overflow, leaving the bowlders and gravel strewn upon its bed; while they may not be seen at all upon the prairie surfaces around them.

This latter fact being misunderstood has led to the supposition, that, being absent upon those surfaces, they had been gathered up by human hands and carried to the shores to build the "walls" of; while the truth is, the embankments, as well as the presence of the materials of which they are composed, are due to natural causes alone, and their origin is wholly referrible to the periodic action of ice, aided in some degree by the force of the waves.

The water in the lakelets is usually very low in late autumn, and when winter comes it is sometimes frozen nearly to the bottom in their deepest parts, so that occasionally all the fish are killed by this means. The ice, of course, freezes fast to the bowlders as well as to whatever else may be within its reach, and the expansive power of from one to five miles of freezing water is exerted upon them in a direction from the centre towards the shores,—a power much more than sufficient to move the largest bowlders upon those gentle slopes.

The embankments are from two to six feet high, and from two to twenty feet across the top, and always separate a low piece of ground from the lake; because where the original shore is a little abrupt, and higher than the high-water level, no embankment is formed, but the bowlders are merely thrust against the shore with such force as to render it steep, and often thickly studded with them.

Meeting no such obstruction on a marshy side, the material thrust out accumulates just where the expansive force of the ice is spent. This process repeated year after year, from age to age, has cleared the bottom of the lakelets of their bowlders and other materials, and piled them up in circular ridges upon their shores; and these are the "walls" which have excited so much wonder. It has been observed that the embankments are heaviest on the sides opposite the prevailing winds. This may be accounted for, at least in part, by the fact that the ice being burdened with the material to which it has frozen fast, would thus be floated against those shores when the spring floods had raised the water of the lakes; and in part also by the farther fact that the dashing of the waves would be most constant against those shores.

Thus it will be seen that whatever was originally upon the bottom, whether bowlders, gravel, sand, or mud, has been carried to the shore, and we find the embankments composed of all these materials arranged in perfectly natural disorder. If bowlders were numerous, the embankment is largely composed of them. If sand prevailed, a broadly rounded embankment is formed, just such as we should expect from such material; and where a peat marsh extends out into the land, an embankment of turf is thrown up at the water's edge, which, being supported by living rootlets, is frequently high and very narrow. The latter are somewhat numerous, and are often called beaver-dams; but this is also a misconception, because beavers never attempt to dam still waters. They dam running streams to obtain ponds of still water. Thus we see that the same natural force placed the bowlders in the embankments that brought them down from their northern homes, namely, the expansive power of ice.

If its crust should remain perfectly stable long enough, the earth would become nearly a perfect sphere by the disintegration of its exposed substance, and the levelling force of gravitation. It is true that its inequalities of surface are now very insignificant compared with the vastness of its bulk; but, in such a case, there would be no mountains, no islands, no continents. All would be an endless and shoreless sea. The erosion of the river valleys, and the consequent drainage of a majority of the primitive lakelets, may be regarded as the first steps in this levelling process, after the glaciers had ceased from the Great Valley; for its post-glacial geology seems to warrant no subdivision into epochs such as are made for other regions. Therefore the whole is here referred to the Terrace epoch. Long before this levelling process can approach completion, other elevations and depressions will be formed upon the changing surface. See, then, how small a part of such a result has been accomplished even by the erosion of the valleys of the great Mississippi and its branches. A part of the primitive lakelets, and a part of the original surface of the drift still remain almost unchanged since their formation. The prairies have still their ocean-like surfaces, and the greatest change the lakelets have undergone in that immense lapse of time is the formation of their insignificant embankments, if aught in nature may be called insignificant. Let us look a little to what has been accomplished by erosion in the Great Valley* during the Terrace epoch as before defined.

Along the courses of what are now the Mississippi and Missouri Rivers, large depressions formerly existed which formed lake-like expansions of those rivers. Thus after the Mississippi had made for itself a definite valley, but before it had cut its channel down to its present level through the rocky obstruction at the Keokuk rapids, that portion of it which borders a large part of the eastern side of Iowa was little else than a lake which averaged about five miles wide, and filled the space between what are now the bluffs that border each side of its broad flat valley.

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*It will be observed that the word *valley* is used with two separate significations; one applied to the hydrographic basin drained by a certain principal stream and its tributaries, and the other to the depression occupied by any particular stream, and which its own waters have cut out of the general surface.

This is proven by the existence there of terraces composed of very fine sedimentary material such as could have been deposited only in comparatively still waters, and also by the existence in that sediment of shells which inhabit still waters only,—the same species which now inhabit fresh-water lakes. River shells, such as now exist in the river, are found on the sides of the bluffs near the rapids at a height of seventy feet above the present high-water mark; and since such beds of shells exist only at low-water mark when alive, upward of eighty feet must be estimated as the height of the river above its present level at the time they lived. It will be observed that river, and not lacustrine shells are found near the rapids. This is accounted for by the fact that the obstruction which caused them, being a flinty formation, and not so easily disintegrated as the other rocks are over which the river runs, has existed as such from its earliest history. Consequently the water there always had a considerable current, while farther to the northward there was too little current to produce a congenial habitat for those shells. The estimated eighty feet is doubtless only a part of the actual height from which the erosion of the Mississippi Valley has reached, because it now averages about two hundred feet deep from the general prairie surface. Thus we see that when that lake-like expansion existed in the Mississippi River, its valley had already been eroded to a considerable depth, and the Terrace epoch was well advanced. But on the other side of the State we have proof of the existence, in the early part of that epoch, of a lake which was larger and deeper than Lake Erie. This proof consists principally in the presence there of a peculiar lacustrine deposit extending at least from the Big Sioux to the mouth of the Kansas River, and from twenty to thirty miles on each side of the Missouri River, through which the latter has cut its present valley, in some places to a depth of more than two hundred feet before it reached the drift which was deposited there during the Glacial epoch. That material is known to have been deposited in fresh water, because only fresh-water shells are found in it, and they are found in it from top to bottom. It is known to have been deposited in still water, because the same kinds of shells are now living in still water only, and because the whole deposit is a fine homogeneous material without sand, gravel, bowlders, or any thing else, except what would have been deposited in a lake of *muddy* water.

It has been claimed by a few geologists that at the close of the Glacial epoch a shallow fresh-water lake occupied the whole hydrographic basin of the Mississippi, and that the fine soil and subsoil of the prairies and other lands of the whole region, as well as the peculiar deposit just referred to, are identical in their formation, and had their origin in one and the same broad lake. Upon this hypothesis some have accounted for the origin of the prairies and for the absence of trees upon them; but the fact is, prairies exist upon both these deposits, and it would require direct effort to keep all kinds of indigenous trees from encroaching upon the prairies if there were no annual fires.

It is not improbable that such a wide-spread sheet of fresh water did exist at that time, and that a large part of the sedimentary material that composes our soil and subsoil had such an origin. But that is widely different in physical characters from the deposit under discussion, which evidently had a different, as well as a subsequent origin. These circumstances seem to leave no room to doubt that a well-defined lake existed there after the continent had in great part become dry land, but before the great rivers had cut their valleys down to any considerable depth. The lake, although so large and deep, was doubtless filled with sediment to the general prairie level within a comparatively short time after the glaciers ceased, just as the sediment of the same river which then flowed into and from it, now speedily fills the reservoirs of the St. Louis Water-works, so that they must often be reëxcavated. Just as the same river would now fill with the same kind of sediment any depression, however large, if such existed in its course.

The great northern lakes are not thus filled, because their tributary streams are pure; and their streams are pure because they flow over geological formations that are not easily disintegrated; while the main tributary of that ancient lake, the Missouri River, is even now one of the muddiest streams on the globe. In the earlier portion of the Terrace epoch it was, if possible, more so; for then as now, it gathered up its sediment from that broad region occupied by the friable rocks of the Tertiary and Mesozoic ages, stretching far away toward the Rocky Mountains, at that time strewn with the grindings fresh from those "mills of the gods"—the glaciers.

The formation of the basin in which the lake rested is known to have taken place during the Glacial epoch, because the drift, with its striated bowlders, now covers its bottom beneath the lacustrine deposit, and because the cutting out of the river valley has exposed, in a number of places, the stratified rocks which the drift rests upon, whose surfaces were scored and striated by the moving glaciers of that epoch. It is known that the filling of the lake with sediment occurred in the early part of the Terrace epoch, because it was filled up even with the prairie surfaces, which would not have been done if the Missouri River had first eroded its valley to any considerable depth below the lake. We know that the lake was so far filled with sediment before it was drained, that it was little else than a marsh, because the top of that deposit of sediment is now nearly even with the higher prairie surfaces, and because the river bluffs which it forms are as high as those formed of the usual materials, —the drift and stratified rocks.

The physical characters of this lacustrine deposit are so peculiar, that they attract the attention of every person who becomes acquainted with it, although a stranger might pass over the formation without observing more than its peculiar outline of bluffs. It is perfectly uniform in character and color from top to bottom, and a hundred miles of distance show no more difference than a hundred feet. It is of a slightly yellowish ash-color, except where rendered darker by decaying vegetation, very fine, not sandy, and yet not adhesive. At the surface it makes excellent soil, and is just as fertile if obtained at a depth of two hundred feet. It is easily excavated by the spade alone, and yet it remains so unchangeable by the atmosphere and frost, that wells dug in it require to be walled only to a point just above the water-line, while the remainder stands so securely without support that the spade-marks remain upon it for many years. Road embankments upon the sides of excavations stand like a wall, showing the names of ambitious carvers long after an ordinary bank of earth would have disappeared. As that part of the valley of the Missouri River below the lake was deepened during the Terrace epoch by the natural process of erosion, the peculiar material which its own waters had previously deposited offered little obstruction to that process, but was readily swept out again as muddy water, and sent on its way to the sea. Thus no more of it was cut out than served to form the valley, which is from four to twelve miles wide, while the larger part remained, forming the bluffs, and extending far inland from the river. The tributary streams which at first emptied into the lake, now traverse its ancient bed of sediment to the river, and have cut down their own valleys to meet it. The sides of these valleys where they traverse that sedimentary deposit are steep like the river-bluffs, and the streams being smaller, their valleys are narrow and very deep. This is particularly true of all those Iowa streams that empty into the Missouri River above Council Bluffs, and they thus present great obstacles to the construction of lines of railway directly east and west through that State. For this reason, and for the purpose of connecting with the great Pacific Railway at Omaha, the more northern of those lines are diverging to the southward down the valleys of the streams, instead of crossing them, so that passengers will pass dry-shod through the bed of that ancient lake, although many fathoms beneath the level at which its waters used to rest.

The peculiar outline of the bluffs along the Missouri River valley is one of the most interesting features of this remarkable deposit. As one views them in the distance, and in their nakedness, for they are often entirely destitute of trees, towering up from the level bottom-land, sometimes more than two hundred feet in height, so steep in some places that a man cannot climb them, he can hardly rid himself of the idea that they are supported by a frame-work of rocks as other bluffs are. Yet not a rock or pebble of any kind or size exists above their base of drift, except a few calcareous concretions which were formed from the limy water that now percolates through the whole mass. The form and arrangement of their numerous rounded prominences sometimes present views of impressive beauty as they stretch away in the distance, or form bold curves in the line of hills.

A few miles below the city of Council Bluffs, they present a full crescentic front to the westward, with the broad Missouri bottom stretching miles away from their base to the river. Their only vegetation here is a covering of wild grasses, and as the mound-like peaks and rounded ridges jut above each other, or diverge in various directions while they recede backwards and upwards to the higher lands, the setting sun throws strange and weird shadows across them, producing a scene quite in keeping with that wonderful history of the past of which they form a part.